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FLOOD INSURANCE STUDY

MASON COUNTY, WASHINGTON
UNINCORPORATED AREAS

MAY 17, 1988

Federal Emergency Management Agency

COMMUNITY NUMBER - 530115

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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Exhibit 2 - Flood Boundary and Floodway Map Index
Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the unincorporated areas of Mason County, Washington, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by United Industries Corporation, for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-C-0281. This study was completed in May 1983. The analysis for the reach of Hood Canal adjacent to Kitsap County was performed by Tudor Engineering Company under Contract No. H-4025.

1.3 Coordination

Streams requiring detailed study were identified at the initial coordination meeting held in June 1980 and attended by representatives of the study contractor, FEMA and Mason County.

An intermediate coordination meeting was held on October 21, 1983, and attended by representatives of the study contractor, FEMA, and Mason County. The intent of that meeting was to explain NFIP regulations, in general, and the flood plain management ordinances for Mason County, in particular.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the unincorporated areas of Mason County, Washington. The area of study is shown on the Vicinity Map (Figure 1).

Flooding on 22.1 miles of streams was studied by detailed methods. Portions of 13 streams, totalling 26 miles, and approximately 135 miles of shoreline were studied by approximate methods. With the exception of the North and South Forks Skokomish River and Vance and Mill Creeks, preliminary studies of the approximate-study areas indicated that the flood boundaries presented on the Flood Hazard Boundary Map (FHBM) for Mason County (Reference 1) were adequate. Therefore the approximate flooding shown on the FHBM was adopted without modification for these approximate-study areas. The study areas are summarized in Table 1. The detailed study of Hood Canal, adjacent to Kitsap County, was adopted from the Flood Insurance Study for Kitsap County (Reference 2).

Areas not included in this study include Skokomish Indian Reservation, the City of Shelton, and Squaxin Island Indian Reservation. However, where flood boundaries and other flood data were available, they are shown within the areas not included.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through May 1988.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and Mason County.

2.2 Community Description

Mason County is located in west-central Washington, northwest of Olympia and southwest of Bremerton. Mason County shares boundaries with Jefferson County on the north, Kitsap and Pierce Counties on the east, Thurston County on the south, and Grays Harbor County on the south and west.

Because it is situated near Hood Canal and the Olympic National Forest, Mason County has a variety of natural resources including timberlands, spawning streams, wildlife habitats, oyster beds, and gravel.

The U.S. Bureau of the Census reported populations of 16,251 in 1960, 20,918 in 1970, and 31,184 in 1980. The Washington State Office of Financial Management projected a population of 37,590 by 1990 (Reference 3).

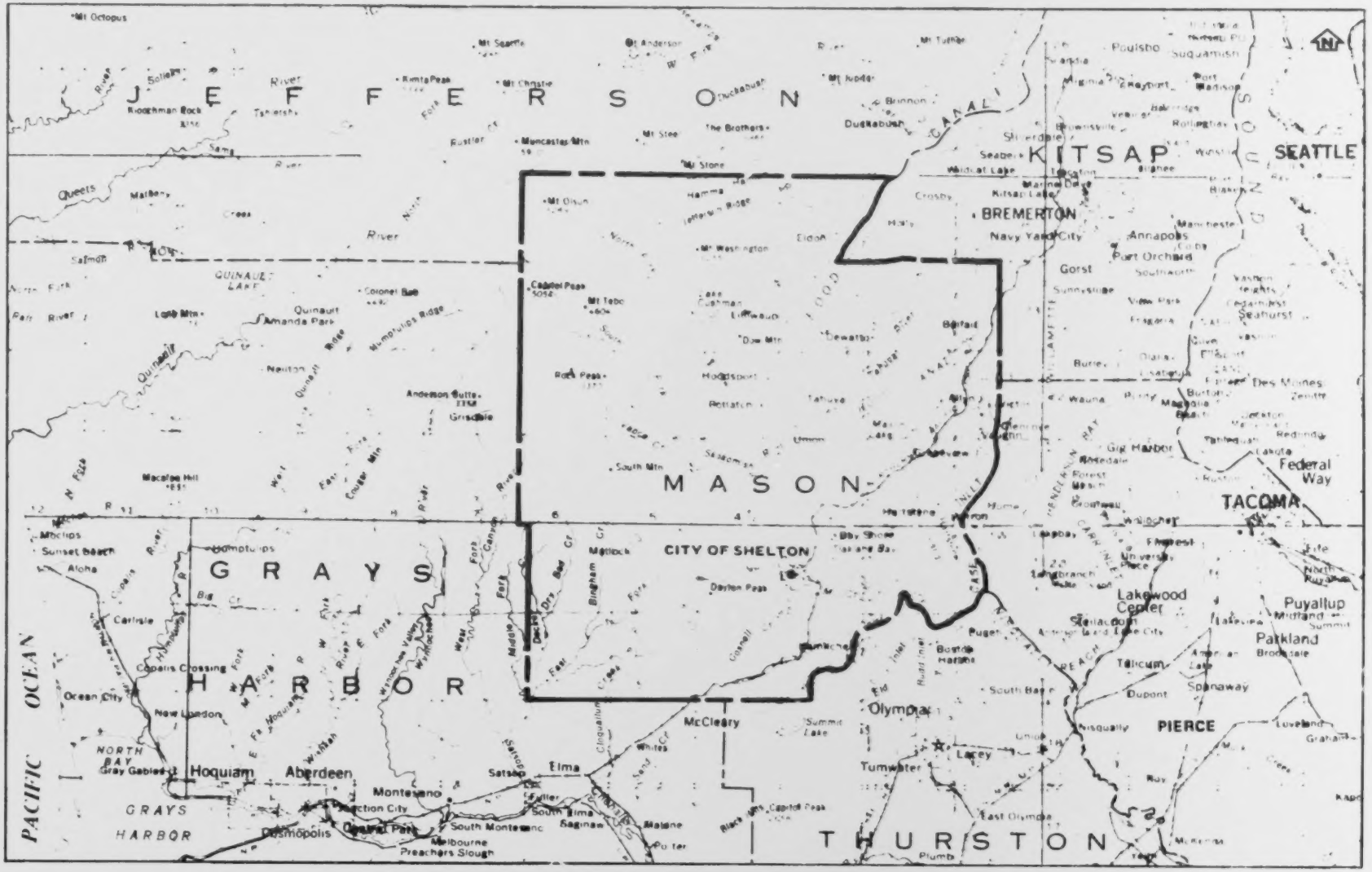

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

APPROXIMATE SCALE

16 0 16 32 48 MILES

VICINITY MAP

Table 1. Study Areas

Source	Type of Study	Length (Miles)	Limits/Location
Skokomish River	Detailed	6.3	From the State Highway 106 bridge to the confluence with the North Fork Skokomish River
Tahuya River	Detailed	9.0	From the North Shore Road bridge to the County Road 7698 (Haven Way) bridge
Union River	Detailed	5.0	From the North Shore Road (State Route 300)bridge to the northern county limits
Goldsborough Creek	Detailed	0.8	From Shelton corporate limits to the section line, all within Section 24, Township 20 North, Range 4 West
Coffee Creek	Detailed	1.0	From its confluence with Goldsborough Creek to a point 0.3 mile upstream of West Deegan Road
Hood Canal	Detailed	7.3	Shoreline on the west side of Hood Canal opposite Kitsap County.
Lynch Cove	Approximate	4.0	Shoreline within Sections 31 and 32, Township 23 North, Range 1 West and within Section 6, Township 22 North, Range 1 West
East Fork Satsop River	Approximate	1.7	From the southern county limits to County Road 220
Middle Fork Satsop River	Approximate	0.5	From the southern county limits to the western Mason County limits
Decker Creek	Approximate	1.8	All within Section 30, Township 19 North, Range 6 West
Skookum Creek	Approximate	1.9	From its mouth to State Route 108

Table 1. Study Areas (Continued)

Source	Type of Study	Length (Miles)	Limits/Location
Mill Creek	Approximate	8.5	From its mouth to Isabella Lake
Deer Creek	Approximate	1.1	From its mouth to the section line of Section 36, Township 21 North, Range 3 West
Cranberry Creek	Approximate	1.0	From its mouth to the section line of Section 36, Township 21 North, Range 3 West
North Fork Skokomish River	Approximate	1.5	From its confluence with South Fork Skokomish River to the northern section line of Section 7, Township 21 North, Range 4 West
South Fork Skokomish River	Approximate	1.9	From its confluence with North Fork Skokomish River upstream 1.9 miles, within Sections 7 and 18, Township 21 North, Range 4 West and Section 12, Township 21 North, Range 5 West
Vance Creek	Approximate	2.9	From its confluence with South Fork Skokomish River upstream 1.9 miles, within Section 18, Township 21 North, Range 4 West and within Sections 11, 12, and 13, Township 21 North, Range 5 West
Sherwood Creek	Approximate	1.3	From its mouth to the western section line of Section 30, Township 22 North, Range 1 West
Mission Creek	Approximate	0.2	From its mouth to State Route 300
Hamma Hamma River	Approximate	1.8	From its mouth to the falls
All Salt Water Shorelines (exceptions: see Lynch Cove and Hood Canal as described previously)	Approximate	131.0	Within Mason County

Through west-central Mason County, the Skokomish River flows easterly from the Olympic Mountain slopes to its mouth in Hood Canal. It is 9 miles long from its mouth to the confluence of the North and South Forks Skokomish River. The North Fork Skokomish River is 34.1 miles long and the South Fork Skokomish River is 27.7 miles long. At the mouth of the Skokomish River, the total drainage area is 244.10 square miles. The Skokomish Valley area shows many former courses and natural levels as the Skokomish River has meandered across the flood plain in past centuries.

The Union River flows southerly through northeastern Mason County, from near Bremerton to Lynch Cove. The Union River is 12.1 miles long and has a drainage area of 25.52 square miles.

The Tahuya River flows southerly through north-central Mason County, from Tahuya Lake to Hood Canal. The Tahuya River is 25.2 miles long and has a drainage area of 47.49 square miles.

Goldsborough Creek flows easterly near the City of Shelton in south-central Mason County, until it discharges into Oakland Bay. It is approximately 12 miles long and has a drainage area of 50.74 square miles. Low, rolling, forest-covered hills, lakes, and marshland make up most of the drainage area. Approximately 80 percent of the land area is maintained for timber and is therefore undeveloped.

Coffee Creek, southwest of the City of Shelton, flows northerly into Goldsborough Creek Coffee Creek is 2.6 miles long and has a drainage area of 5.04 square miles.

The climate of Mason County is predominantly maritime; the summers are comparatively cool and dry, and the winters are mild and wet. The average winter temperatures range from approximately 30°F to approximately 45°F. The summer temperatures for the overall county are generally in the mid-70s.

The precipitation patterns vary across the county due to the Olympic Mountain range in the northwest and Hood Canal and the lowlands in the southeast. Average annual rainfall in the northwest is 200 inches, while in the south the annual average is only 50 inches (Reference 4).

2.3 Principal Flood Problems

Flooding in Mason County generally occurs from November through March; the greatest cause of flooding is heavy rainfall combined with snowmelt.

The Skokomish River floods several times annually. The highest peak flow on the river occurred on November 3, 1955, at 27,000 cubic feet per second (cfs). During that flood, an estimated 5,800 cfs flowed to the overbank area south of the river channel upstream

from U.S. Highway 101. The estimated return period for a flood of this magnitude is 30 years. The flood of January 20-21, 1972, had a flow of 18,500 cfs with a recurrence interval of 4 years. Figures 2 and 3 depict only some of the damages incurred from the 1972 flood.

Yearly averages have been estimated as to probable flooding downstream from U.S. Highway 101. These averages are 1 day in November, 3 days in both December and January, 2 days in February, and 1 day in March. Many homes, pastures, and personal property are damaged annually by smaller flows than those that occurred in 1955 and 1972.

Peak flows on the Union River occurred on February 22, 1949 (1,610 cfs); February 9, 1951 (1,230 cfs); and January 21, 1951 (1,160 cfs). These flows were measured at the gaging station near Belfair. Through discussion of past floods with agency representatives from Mason County, it was found that the damage from the Union River was minimal. Annually the river will have high flows, yet minimal overbank flooding.

On the Tahuya River, peak flows were measured at the gaging station near Belfair on November 3, 1955 (1,210 cfs); February 22, 1949 (900 cfs); and January 5, 1954 (845 cfs). A flow of approximately 3,000 cfs occurred in December 1980. Several homes on the riverbank incurred damage, ranging from bank washouts to silt damage and shifting of a mobile home by several inches.

Goldsborough Creek has had several peak flows in the past 30 years. On January 19, 1968, a flow of 1,430 cfs was recorded. On January 22, 1961, the peak flow was 1,420 cfs. On January 20, 1972, a peak flow of 1,410 cfs was recorded. Figures 4 and 5 depict some of the damage incurred during the flood of February 1935. The magnitude of flows during this flood are unknown because gage records were not kept during that period.

2.4 Flood Protection Measures

No major flood-protection structures are located within the study area. Lake Cushman Dam Nos. 1 and 2 on North Fork Skokomish River and the Casad Dam in Bremerton on the Union River were not designated as flood-control structures.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood

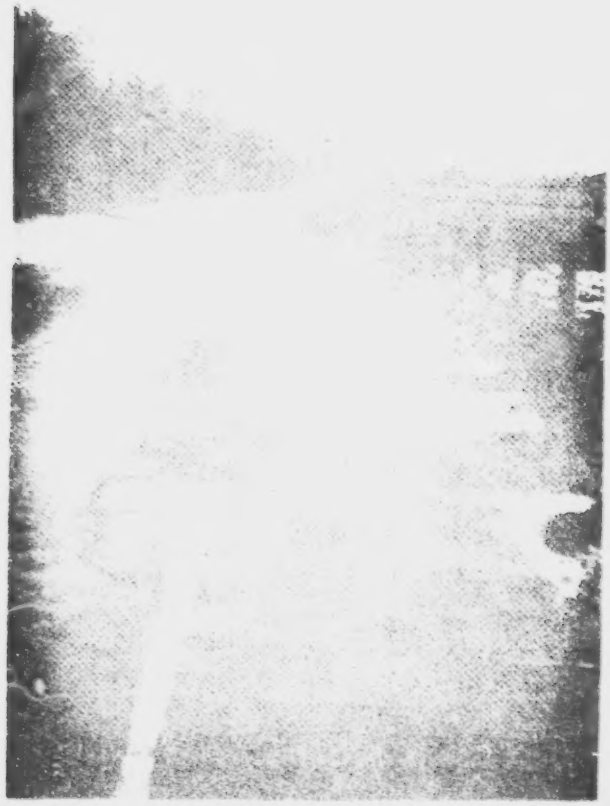

Figure 2. Skokomish River, [illegible] February 21, 1972

Figure 3. Skokomish R[illegible] ...stream of U.S. Route 101, [illegible]

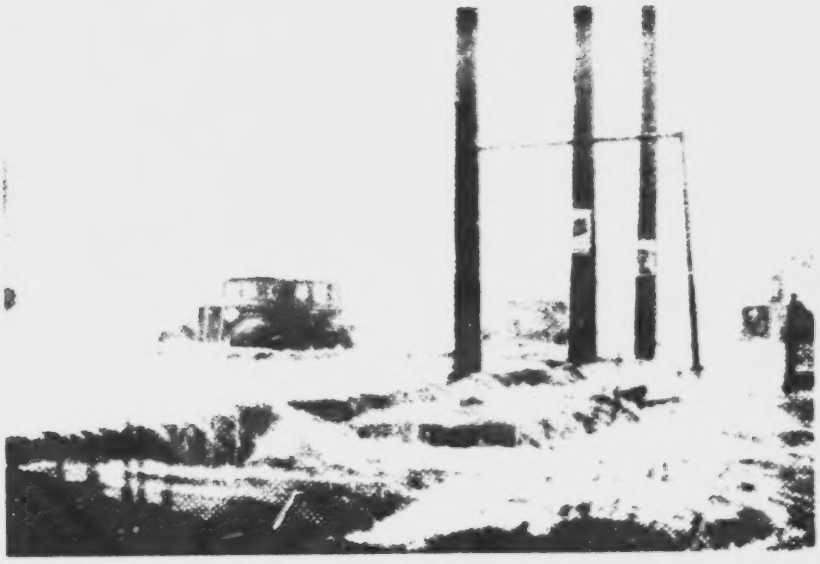

Figure 4. Goldsborough Creek at Old State Route 9, Shelton, Washington, February 1935

Figure 5. Goldsborough Creek at Old State Route 9, Shelton Washington, February 1935

insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each riverine flooding source studied by detailed methods affecting the community.

Synthetic hydrographs, constructed by the U.S. Army Corps of Engineers (COE) HEC-1 Computer Model (Reference 5) using gaging stations operated by the U.S. Geological Survey (USGS), were used to determine peak discharges. Table 2 lists the gages used during the course of this study, along with their lengths of record. The following floods were used in this analysis: November 1, 1977 on the Skokomish River; January 1, 1953 on the Union River; February 22, 1949 on the Tahuya River; and December 15, 1959 on Goldsborough and Coffee Creeks.

Peak discharge-drainage area relationships for the riverine flooding source studied by detailed methods are shown in Table 3.

The attenuation of peak discharges on the Skokomish River is attributed to overbank storage and to constrictions in the floodplain.

It should be noted that on the North Fork Skokomish River, the hydrologic model indicated a significant decrease in peak discharge between Cushman Dam and the confluence with South Fork Skokomish River. This appears to be in agreement with the limited historical data available. The decreasing discharges can be attributed to a combination of factors such as significant amount of storage behind Cushman Dam and in channel reaches and the lack of significant additional drainage areas between Cushman Dam and the confluence.

Several methods were used to determine the peak discharges for streams studied by approximate methods. For streams that were subbasins of the areas studied in detail, North and South Forks Skokomish River and Vance Creek, the peak discharges were available from analysis conducted for the areas studied by

Table 2. USGS Gaging Stations

Gage Name	Gage Number	Period of Record
Skokomish River near Potlach	12061500	December 1934 - March 1979
North Fork Skokomish River below Staircase Rapids	12056500	February 1925 - November 1979
North Fork Skokomish River near Potlatch	12059500	February 1945 - March 1979
North Fork Skokomish River near Hoodsport	12057500	January 1914 - October 1929
South Fork Skokomish River near Hoodsport	12059800	October 1963 - March 1979
South Fork Skokomish River near Potlatch	12060000	January 1924 - October 1963
Union River near Bremerton	12063000	March 1946 - May 1959
Union River near Belfair	12063500	October 1947 - April 1959
Tahuya River near Bremerton	1206600	April 1946 - November 1955
Tahuya River near Belfair	12067500	April 1946 - November 1955
Goldsborough Creek Near Shelton	12076500	January 1952 - March 1979

Table 3. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Union River					
At Mouth	25.52	1,940	2,605	2,785	3,415
Tahuya River					
At Mouth	47.49	4,965	6,390	6,900	8,195
Skokomish River					
At Confluence With North Fork Skokomish River	222.20	25,560	33,010	36,140	43,230
At U.S. Route 101 Bridge	228.50	24,750	31,890	34,910	41,740
At State Route 106 Bridge	237.20	24,280	31,280	34,230	40,940
At Mouth	244.10	23,870	30,760	33,670	40,270
Goldsborough Creek					
Below Confluence With Coffee Creek	49.14	1,850	2,520	2,795	3,450
At Shelton	50.74	1,965	2,660	2,935	3,585
Coffee Creek					
At Confluence With Goldsborough Creek	5.04	495	680	765	950

detailed methods. Mill Creek was studied by regression-correlation techniques using drainage area and normal annual precipitation of the catchments (Reference 6).

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Water-surface elevations of floods of the selected recurrence intervals were computed through the use of the COE HEC-2 step-backwater computer program (Reference 7).

Cross sections for the backwater analyses of the streams studied by detailed methods were obtained from aerial photographs at a scale of 1:36,000 (Reference 8). The below-water sections were obtained by field measurement. All bridges, dams, and culverts were field checked to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Channel and overbank roughness (Manning's "n") used in the hydraulic computations were based by engineering judgment and on field observations of the streams and flood plain areas. Roughness values for each stream are listed in Table 4.

Starting water-surface elevations for the Skokomish River were based on results derived from the approximate study of Annas Bay. Starting water-surface elevations for the Tahuya and Union Rivers were based on results derived from the approximate studies on Lynch Cove. Starting water-surface elevations for Goldsborough Creek are based on the results of 1975 COE reports for Shelton Creek (References 9 and 10). Starting water-surface elevations for Coffee Creek were based on the 10-, 50-, 100-, and 500-year water-surface elevations computed for Goldsborough Creek at their confluence.

Detailed flooding analysis was also performed for a reach along Puget Sound (Hood Canal) adjacent to Kitsap County. Methodology consisted of statistical analysis of the 77 years of tidal elevation records at the nearby Seattle gage to determine the elevations associated with the various frequency floods. Comparison of corresponding historical flood elevations between the Seattle gage and gages in Kitsap County at Port Gamble and Seabeck demonstrated that the average difference in recorded elevations for specific events at these gages was approximately 0.3 foot, with a maximum difference of approximately 0.5 foot.

Table 4. Manning's "n" Values

Stream Name	Channel	Overbank
Union River	0.035-0.115	0.044-0.120
Tahuya River	0.033-0.062	0.057-0.115
Skokomish River	0.041-0.048	0.045-0.110
Goldsborough Creek	0.045-0.052	0.075-0.110
Coffee Creek	0.020-0.052	0.065-0.110

Meteorological effects may cause the water level in Puget Sound to rise as much as 2.5 feet above the predicted tidal elevation. These meteorological effects are greatest when a fast-moving, low-pressure system, accompanied by strong onshore coastal winds, moves over Puget Sound from the southwest. Wind waves produced during these storms will rarely exceed 2 feet because of the limited fetch for south to southwest winds. Wave heights due to high winds were analyzed based on fetch length, wind velocity, exposure direction, and beach slope. One-half of the predicted wave height was added to the predicted tidal height to yield elevations for the various frequency floods (Reference 2).

Elevations for floods of the selected recurrence intervals for flooding sources studied by detailed methods are shown in Table 5.

For portions of the South Fork Skokomish River, North Fork Skokomish River, Vance Creek, and Mill Creek, approximate depths were estimated using normal-depth methods for open channel flow, and available contour maps of the streams.

The approximate coastal analysis for Lynch Cove was based on tidal gage records from Seattle transposed to a tidal gage located closer to Lynch Cove, at Union, Washington. In addition, wave setup and runup components for the tidal elevations were determined by applying wind records from Sea-Tac Airport to methods described in the COE Shore Protection Manual (Reference 11) and several other COE reports (References 12 through 17).

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream

Table 5. Summary of Elevations

Flooding Source & Location	Elevation (Feet NGVD) 10-Year	50-Year	100-Year	500-Year
Hood Canal				
Adjacent to Kitsap County	9.2	9.6	9.8	10.1

studied by detailed methods, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps developed from aerial photographs at a scale of 1:36,000, (Reference 8).

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the South Fork Skokomish River, North Fork Skokomish River, Vance Creek, and Mill Creek, approximate flood plain boundaries were delineated using USGS topographic maps (References 18, 19, and 20). For these streams studied by approximate methods, only the 100-year flood plain boundary is shown.

Approximate 100-year flood plain boundaries in some portions of the study area were taken directly from the Flood Hazard Boundary Map for Mason County (Reference 10).

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 6).

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Union River								
A	6,408	297	1,018	2.6	13.9	13.9	14.0	0.1
B	7,843	450	970	2.7	18.5	18.5	18.5	0.0
C	9,168	289	992	2.7	23.7	23.7	23.7	0.0
D	11,818	169	441	6.0	34.6	34.6	34.6	0.0
E	12,298	124	520	5.1	37.5	37.5	37.5	0.0
F	13,523	350	741	3.0	44.0	44.0	44.0	0.0
G	14,398	185	639	3.5	50.1	50.1	50.2	0.1
H	14,838	178	591	3.2	53.7	53.7	53.7	0.0
I	15,018	167	567	3.4	55.2	55.2	55.2	0.0
J	16,868	314	702	2.7	67.9	67.9	67.9	0.0
K	18,008	330	1,106	1.7	72.0	72.0	72.2	0.2
L	19,983	235	555	3.4	81.6	81.6	81.7	0.1
M	21,083	261	830	2.3	85.9	85.9	85.9	0.0
N	25,058	230	470	4.1	103.0	103.0	103.0	0.0
O	26,508	353	905	2.1	111.9	111.9	111.9	0.0
P	27,241	84	249	7.7	115.0	115.0	115.0	0.0
Q	29,091	170	485	3.0	127.6	127.6	127.6	0.0
R	29,891	140	787	1.8	128.6	128.6	128.6	0.0

[1]Feet Above Mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

FLOODWAY DATA

UNION RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Tahuya River								
A	310	117	1,399	4.9	9.1	9.1	10.1	1.0
B	620	335	3,347	2.1	9.7	9.7	10.6	0.9
C	1,610	410	3,400	2.0	9.9	9.9	10.8	0.9
D	3,030	490	2,679	2.6	10.7	10.7	11.6	0.9
E	4,710	628	3,800	1.7	11.9	11.9	12.7	0.8
F	6,650	676	2,004	3.3	15.6	15.6	16.2	0.6
G	9,240	1,060	2,267	2.8	22.9	22.9	23.7	0.8
H	11,150	500	1,607	4.0	31.5	31.5	31.5	0.0
I	12,450	710	2,103	3.0	36.1	36.1	36.9	0.8
J	13,650	740	2,563	2.4	41.4	41.4	42.4	1.0
K	15,320	610	1,658	3.7	48.9	48.9	49.6	0.7
L	17,650	720	1,859	3.3	58.1	58.1	58.8	0.7
M	19,060	570	1,508	4.0	66.1	66.1	66.4	0.3
N	20,830	650	2,537	2.4	72.2	72.2	73.1	0.9
O	23,000	440	1,629	3.6	80.1	80.1	80.3	0.2
P	24,700	684	2,035	2.9	85.8	85.8	86.6	0.8
Q	25,670	475	1,249	4.7	90.0	90.0	90.3	0.3
R	26,600	430	1,427	4.0	95.5	95.5	96.5	1.0
S	27,900	455	1,491	3.7	106.7	106.7	107.4	0.7
T	28,450	350	1,395	3.9	109.9	109.9	110.4	0.5
U	30,610	147	853	6.1	119.9	119.9	119.9	0.0
V	32,610	250	1,347	3.9	126.8	126.8	127.2	0.4
W	33,310	353	1,183	4.4	129.1	129.1	129.4	0.3
X	34,290	105	808	6.1	133.2	133.2	133.4	0.2
Y	35,070	250	1,227	4.0	135.9	135.9	136.3	0.4
Z	35,980	500	1,520	3.2	138.5	138.5	139.2	0.7

[1]Feet Above Mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

FLOODWAY DATA

TAHUYA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Tahuya River (Cont'd)								
AA	37,200	628	1,320	3.5	142.9	142.9	143.6	0.7
AB	38,330	499	1,498	3.1	146.5	146.5	147.4	0.9
AC	40,290	170	644	6.8	154.7	154.7	154.7	0.0
AD	42,100	100	684	6.4	162.9	162.9	163.7	0.8
AE	42,660	75	580	7.2	165.5	165.5	165.9	0.4
AF	43,800	125	733	5.7	168.3	168.3	168.9	0.6
AG	44,190	140	574	7.3	169.8	169.8	170.3	0.5
AH	44,650	179	938	4.3	172.2	172.2	172.8	0.6
AI	45,100	115	637	6.3	173.7	173.7	174.0	0.3
AJ	45,340	80	525	7.6	174.9	174.9	175.3	0.4
AK	45,640	100	636	6.3	176.9	176.9	176.9	0.0

[1]Feet Above Mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

FLOODWAY DATA

TAHUYA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Skokomish River								
A	12,270	713[2]	8,273	4.1	15.8	15.8	16.4	0.6
B	12,960	1,070[2]	10,411	3.3	16.8	16.8	17.3	0.5
C	13,500	1,595[2]	15,864	2.2	17.2	17.2	17.9	0.7
D	16,280	2,897[2]	23,200	1.5	18.1	18.1	18.8	0.7
E	19,950	4,235[2]	31,135	1.1	19.1	19.1	19.7	0.6
F	22,640	4,550[2]	24,835	1.4	20.0	20.0	20.4	0.4
G	24,030	4,431[2]	19,607	1.8	21.3	21.3	21.8	0.5
H	25,350	4,450[2,3]	15,733	2.2	22.7	22.7	23.0	0.3
I	26,900	3,816[2,3]	4,994	7.0	26.8	26.8	26.8	0.0
J	27,300	4,131[2]	23,439	1.5	28.1	28.1	28.1	0.0
K	28,160	4,297[2]	21,142	1.7	28.5	28.5	28.5	0.0
L	29,310	3,999[2]	14,233	2.5	29.9	29.9	30.0	0.1
M	31,420	3,891	16,582	2.1	32.2	32.2	32.4	0.2
N	32,770	3,008	15,337	2.3	34.0	34.0	34.3	0.3
O	34,040	2,200	7,863	4.5	37.5	37.5	37.6	0.1
P	35,570	2,354	12,702	2.8	40.6	40.6	40.7	0.1
Q	37,060	2,438	10,589	3.3	42.0	42.0	42.3	0.3
R	38,130	1,610	8,273	4.3	43.6	43.6	44.3	0.7
S	39,320	1,439[3]	10,444	3.4	45.8	45.8	46.7	0.9
T	42,010	2,580	11,278	3.2	50.1	50.1	50.3	0.2
U	43,720	3,550	17,905	2.0	53.8	53.8	54.0	0.2
V	45,570	3,250	11,344	3.2	57.0	57.0	57.2	0.2

[1]Feet Above Mouth [2]Floodway Lies Partially Within Area Not Included--Entire Floodway is Shown on Flood Boundary and Floodway Map [3]Width Includes Areas of Minimal and 500-Year only Flooding Within Floodway

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

FLOODWAY DATA

SKOKOMISH RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Goldsborough Creek								
A	0	69	487	6.0	35.1	35.1	36.1	1.0
B	650	55	365	7.9	38.9	38.9	39.0	0.1
C	1,550	61	427	6.7	43.7	43.7	43.7	0.0
D	1,700	60	427	6.6	44.4	44.4	44.4	0.0
E	1,960	41	311	7.2	45.7	45.7	45.7	0.0
F	2,220	60	424	5.3	47.0	47.0	47.0	0.0
G	3,410	62	303	7.2	51.4	51.4	51.4	0.0
H	4,010	65	295	7.2	56.0	56.0	56.1	0.1

[1]Feet Above Downstream Limit of Deatailed Study

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

FLOODWAY DATA

GOLDSBOROUGH CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Coffee Creek								
A	300	32	162	3.5	46.3	46.3	47.3	1.0
B	530	26	86	6.5	47.4	47.4	47.8	0.4
C	860	25	80	7.0	52.5	52.5	52.5	0.0
D	1,600	36	96	5.8	59.8	59.8	59.8	0.0
E	1,870	9	63	8.8	66.3	66.3	66.3	0.0
F	2,395	300	2,979	0.2	79.8	79.8	79.8	0.0
G	2,745	450	3,205	0.2	79.8	79.8	79.8	0.0
H	5,125	1,900	15,661	0.0	79.9	79.9	79.9	0.0

[1]Feet Above Mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

FLOODWAY DATA

COFFEE CREEK

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 6.

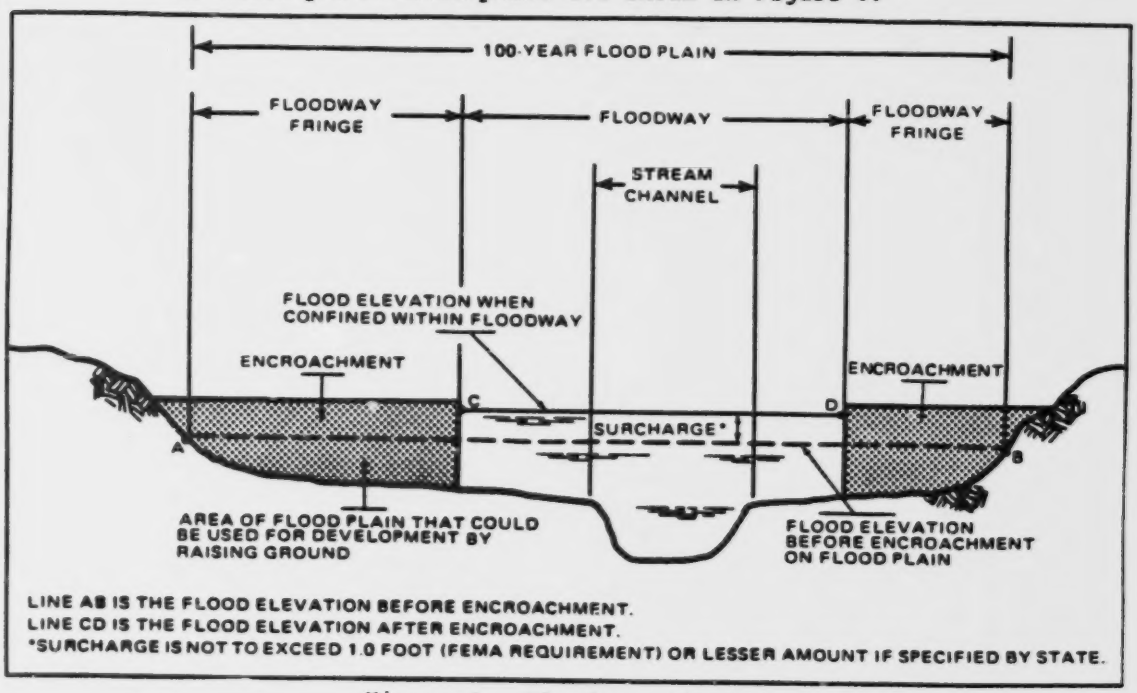
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

Figure 6. Floodway Schematic

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied by detailed methods affecting the unincorporated areas of Mason County.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard. In riverine areas, reaches are based on the average weighted difference in water-surface elevations between

the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the riverine flooding sources of Mason County are shown on the Flood Profiles (Exhibit 1), and the reaches are summarized in Table 7.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10-and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zones A1-A3, A9, and A17:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (FEET NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Union River							
Reach 1	0070,0135	-0.86	-0.20	0.56	010	A2	Varies - See Map
Tahuya River							
Reach 1	0110,0120, 0130	-0.51	-0.65	0.22	005	A1	Varies - See Map
Skokomish River							
Reach 1	0180	-1.18	-0.32	0.66	010	A2	Varies - See Map
Goldsborough Creek							
Reach 1	0190,0255	-1.64	-0.45	1.04	015	A3	Varies - See Map
Coffee Creek							
Reach 1	0255	-1.16	-0.32	0.66	010	A2	Varies - See Map
Reach 2	0255	-8.66	-2.94	0.36	085	A17	Varies - See Map
Reach 3	0255	-4.74	-3.08	0.31	045	A9	Varies - See Map
Hood Canal (Puget Sound)							
Reach 1	0050,0075	-0.60	-0.20	0.30	005	A1	10

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

FLOOD INSURANCE ZONE DATA

UNION RIVER-TAHUYA RIVER-SKOKOMISH RIVER-GOLDSBOROUGH CREEK-COFFEE CREEK-HOOD CANAL (PUGET SOUND)

Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other local water-control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flood hazard; not subdivided.

The flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied by detailed methods affecting the community are summarized in Table 7.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for Mason County is, for insurance purposes, the principal product of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the NFIP.

6.0 OTHER STUDIES

USGS published a flood profile report of the Skokomish River in 1974 in cooperation with the State of Washington Department of Ecology (Reference 21).

In cooperation with the Skokomish Tribe Council, USGS published a water resources study in 1973 (Reference 22). This report covers the Skokomish Indian Reservation lands only and does not discuss flooding in detail, yet does discuss the flood plain areas plus descriptions of damage incurred.

A project report of Shelton Creek was published in 1975 by the COE, Seattle District. Although this report covers Shelton Creek, analysis was done on Goldsborough Creek as well. Again, flooding was not discussed in detail, yet characteristics of the drainage basin are discussed as is the extent of flooding incurred (References 9 and 10).

A Flood Hazard Boundary Map (FHBM) for Mason County has been published (Reference 1). In areas studied by detailed or approximate methods, this study represents a more recent and comprehensive analysis, and

therefore, supersedes the FHBM. In other areas, the FHBM was the source of approximate flood boundaries, as described previously.

Flood Insurance Studies have been published for Jefferson and Thurston Counties (References 23 and 24, respectively). A Flood Insurance Study is in progress for Pierce County (Reference 25). Differences in coastal flooding zone designations between the Jefferson County Flood Insurance Study and this study and between the Thurston County Flood Insurance Study and this study are attributed to differences in the scope of study. In all other respects, the results of those studies are in agreement with the results of this study.

A Flood Insurance Study has been published for Kitsap County (Reference 26). A detailed analysis of flooding along Hood Canal in areas adjacent to Mason County was adopted from the Kitsap County FIS for use in this study. A disagreement in flood boundaries and elevations along the Union River between the studies is attributed to more recent and detailed topographic mapping and cross section data used in this study. Because of differences in scope of study, approximate flooding shown along the Dewatto River and a tributary of the Tahuya River in this study is not shown in Kitsap County. In other respects, the studies are in agreement.

A Flood Insurance Study has been published for Grays Harbor County (Reference 26). Because of a difference in scope of study, approximate flooding on Cloquallum Creek is shown in Mason County to the downstream county limits, whereas there is no corresponding approximate flooding shown in Grays Harbor County. Also, approximate flooding from Canyon Creek is shown in Grays Harbor County to the upstream county limits and is not shown in Mason County. Otherwise, the studies are in agreement.

A Flood Insurance Study has been published for the City of Shelton (Reference 21). Because of a difference in scope of study, detailed flooding is shown at Oakland Bay in the City of Shelton, whereas approximate flooding is shown in adjacent areas of unincorporated Mason County. However, flood plain boundaries in these areas are in agreement. Due to differences in the scope of study, an area of approximate flooding shown adjacent the western corporate limits of Shelton is not shown within the city. Otherwise, the studies are in agreement.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Federal Regional Center, 130 228th Street, SW., Bothell, Washington 98021-9796.

8.0 BIBLIOGRAPHY AND REFERENCES

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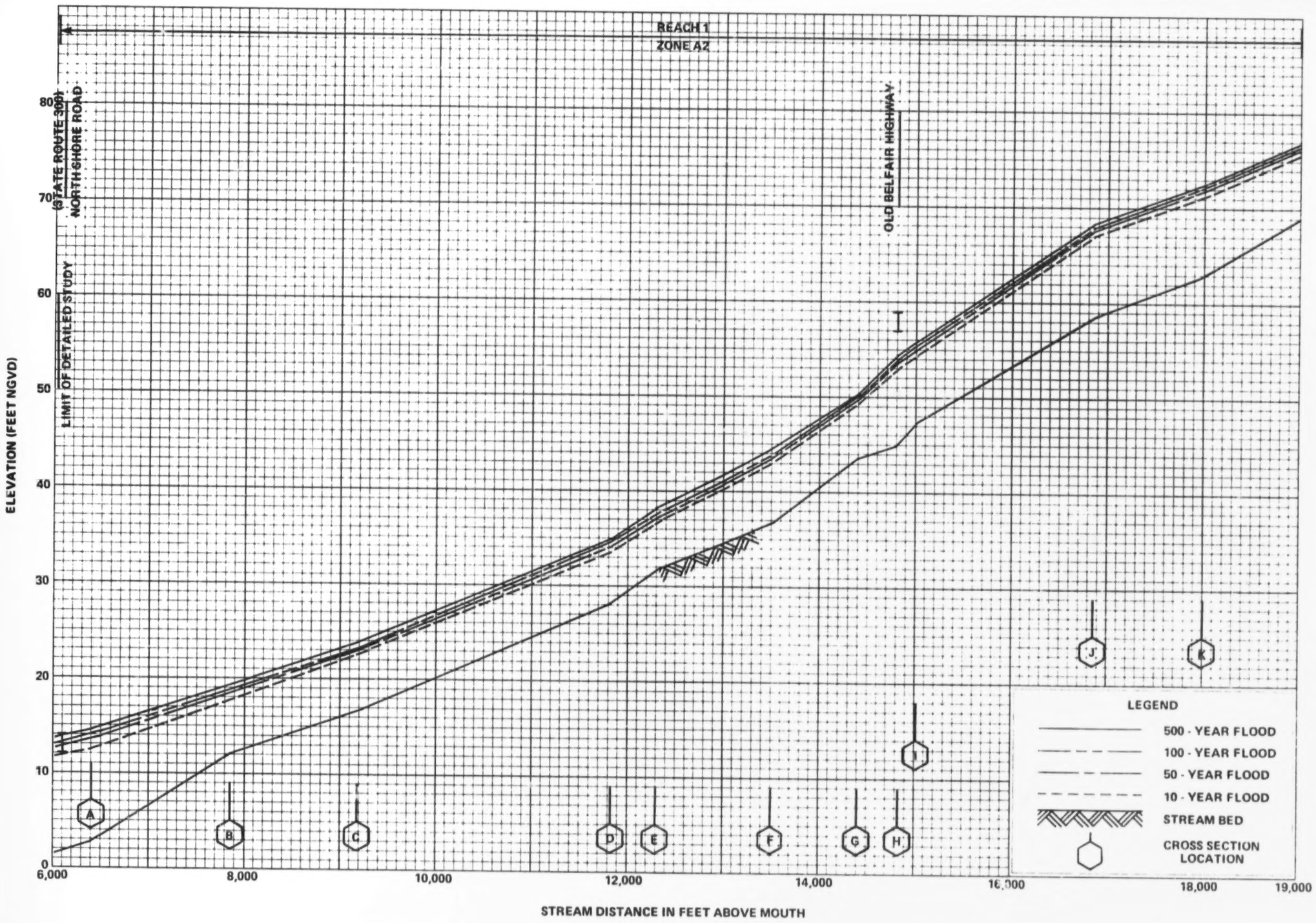


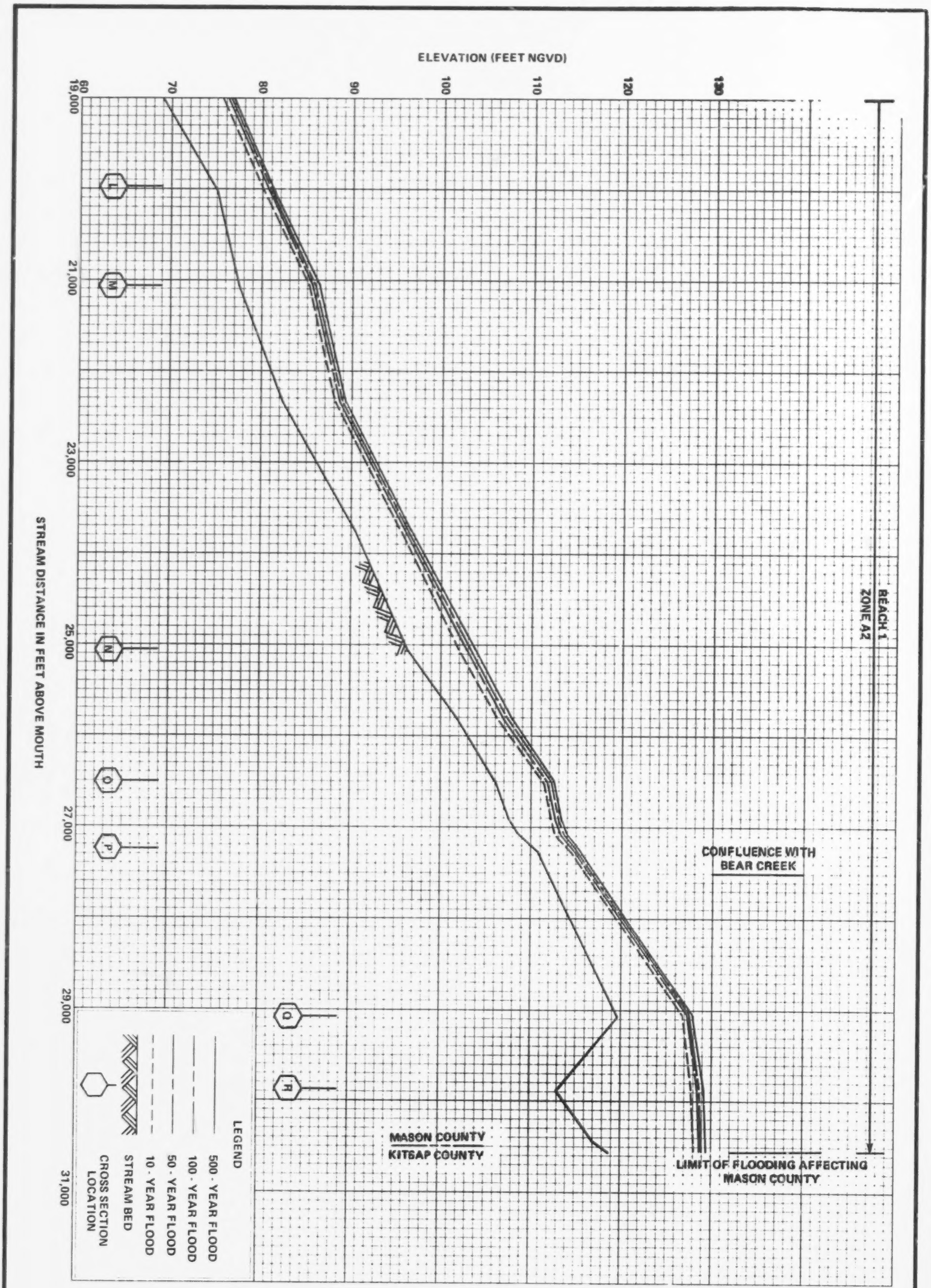
FLOOD PROFILES

UNION RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

01P



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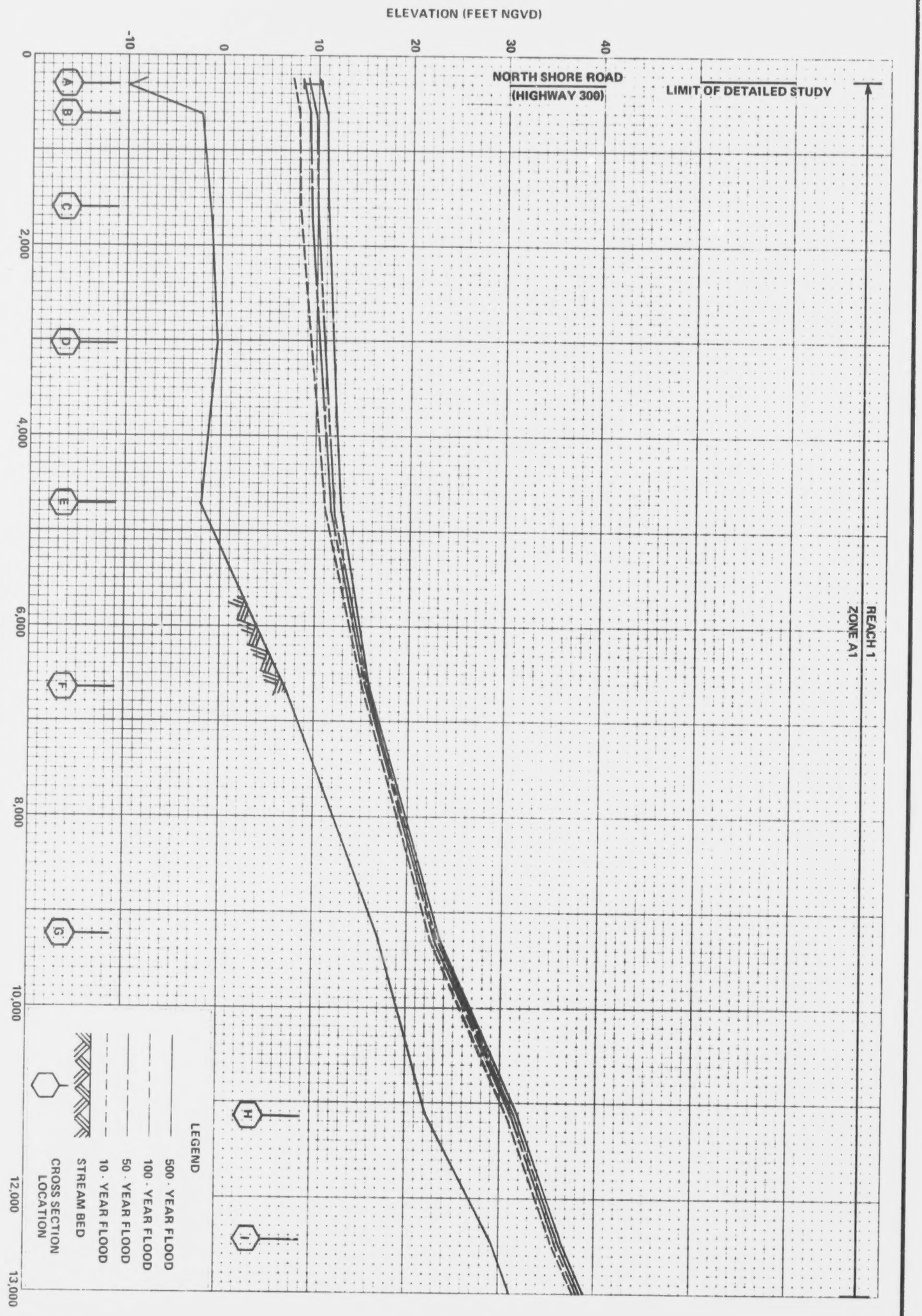
FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

FLOOD PROFILES

UNION RIVER



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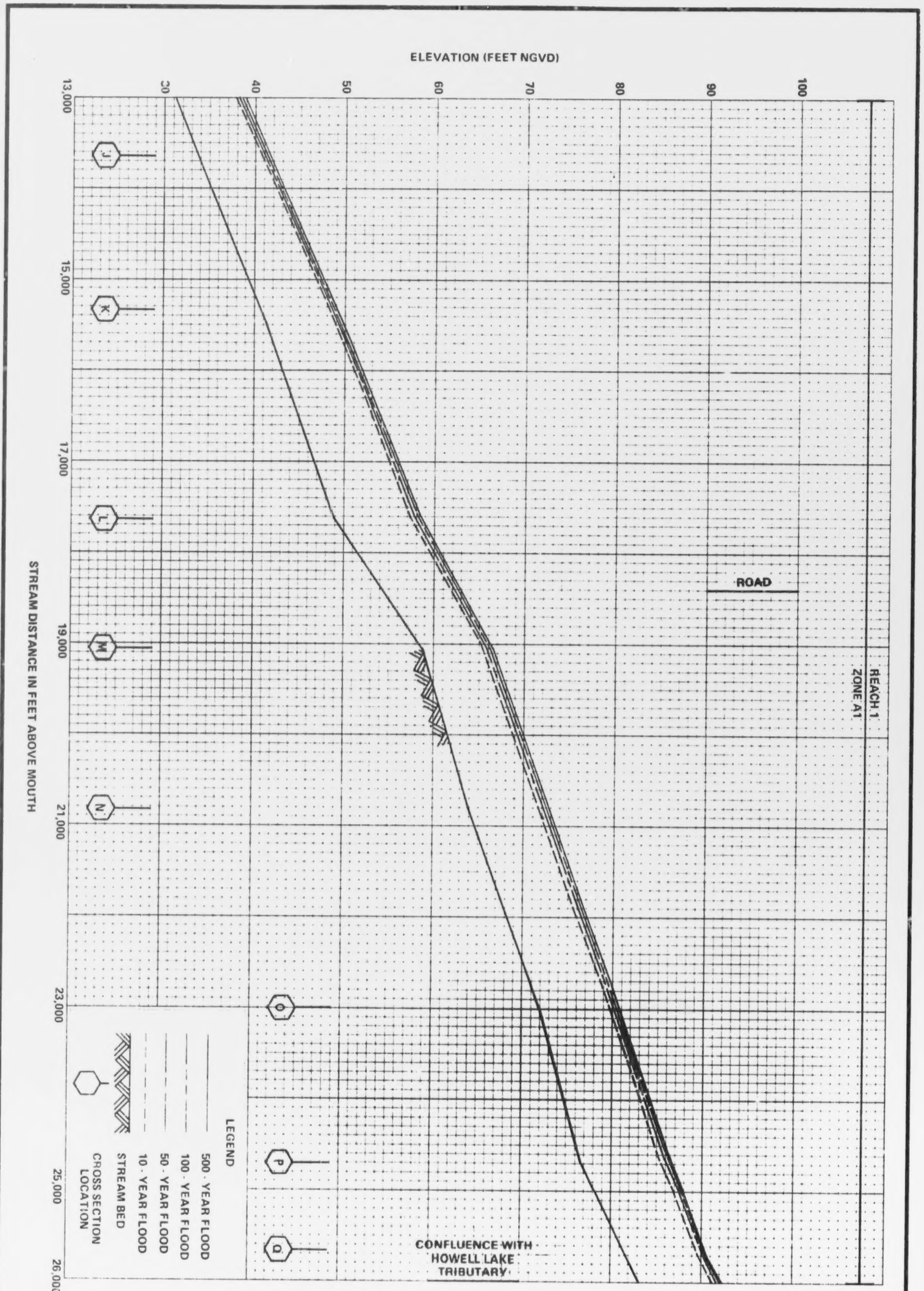
03P

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

FLOOD PROFILES

TAHUYA RIVER



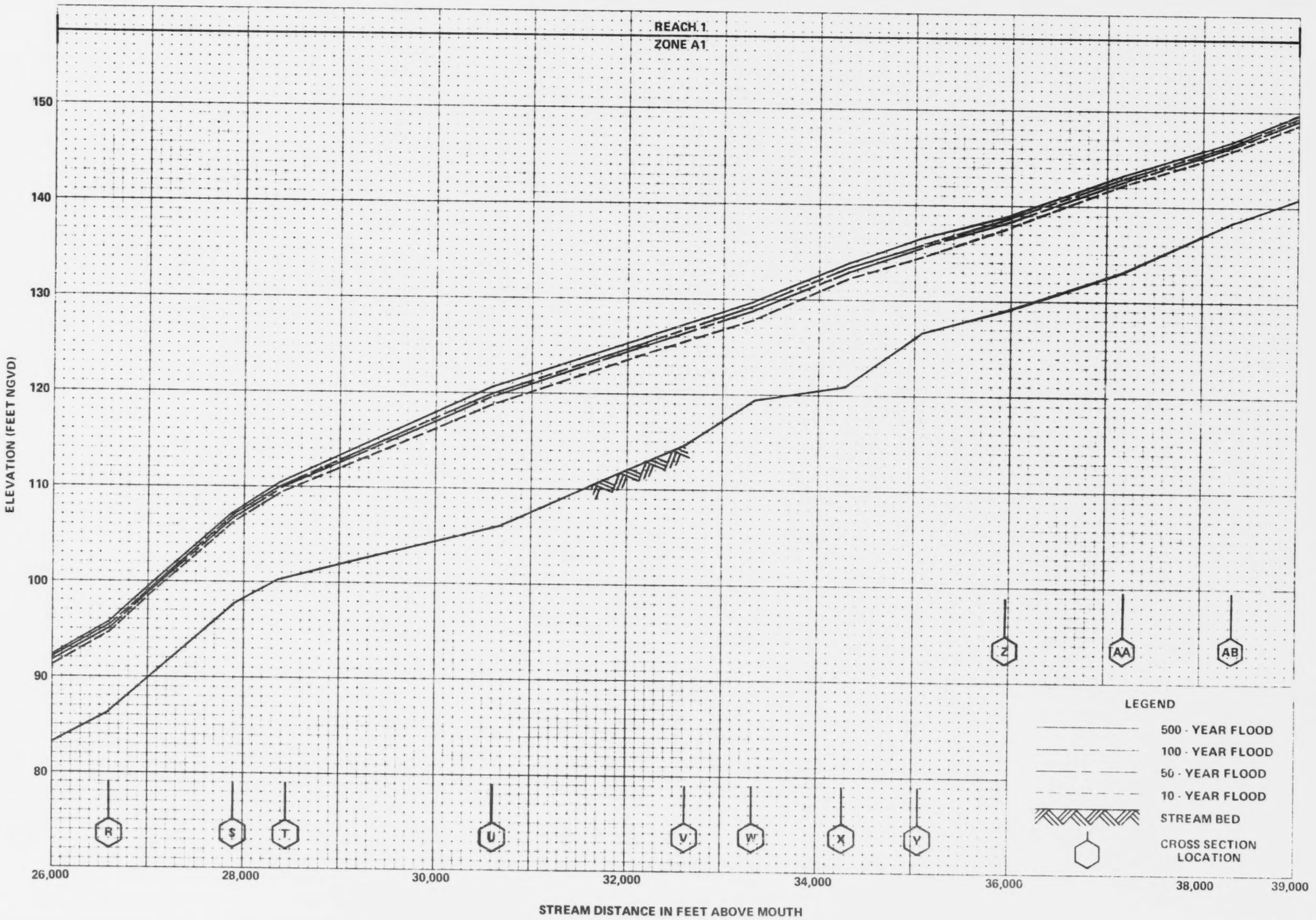
04P

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

FLOOD PROFILES

TAHUYA RIVER



FLOOD PROFILES

TAHUYA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

05P

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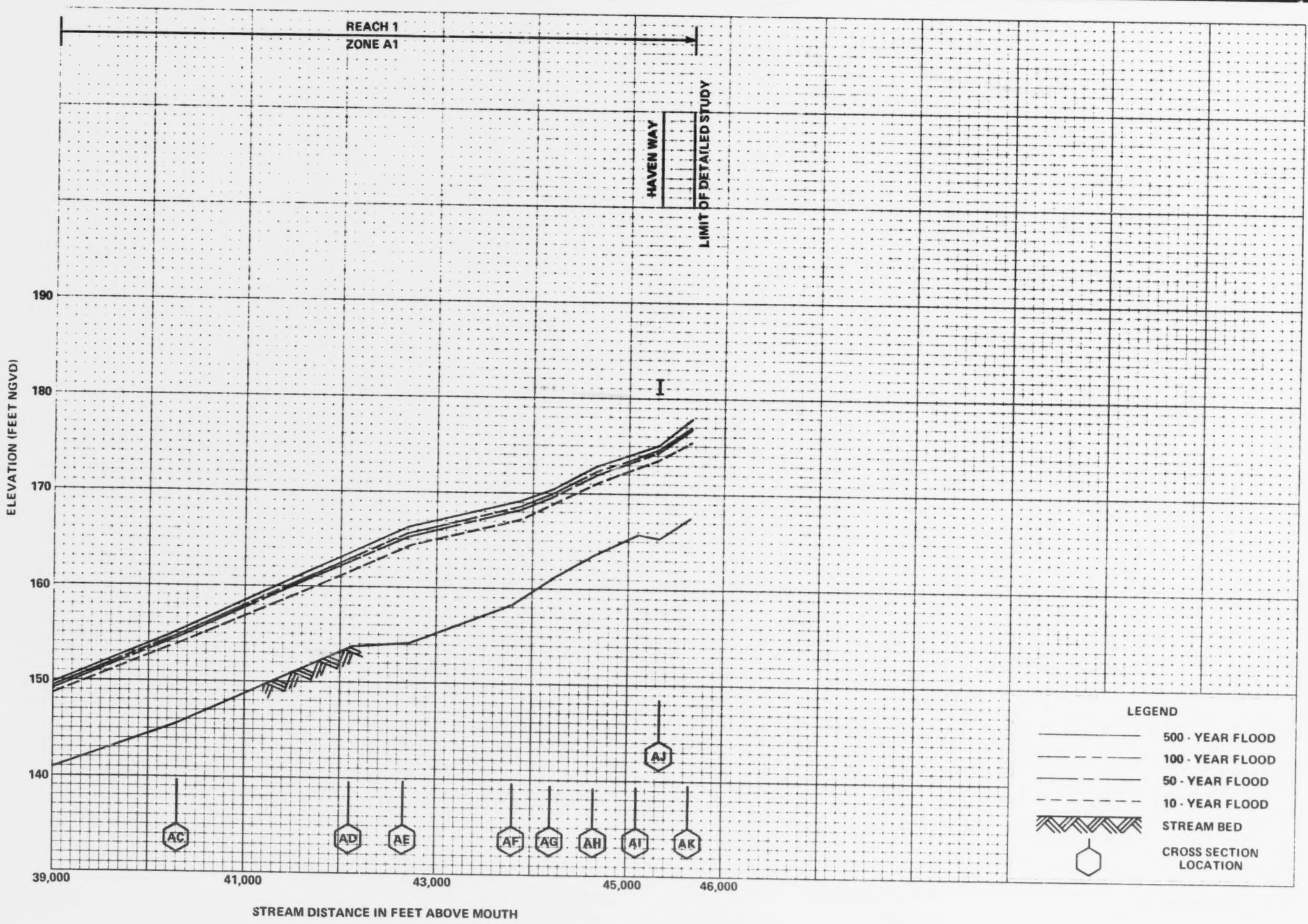


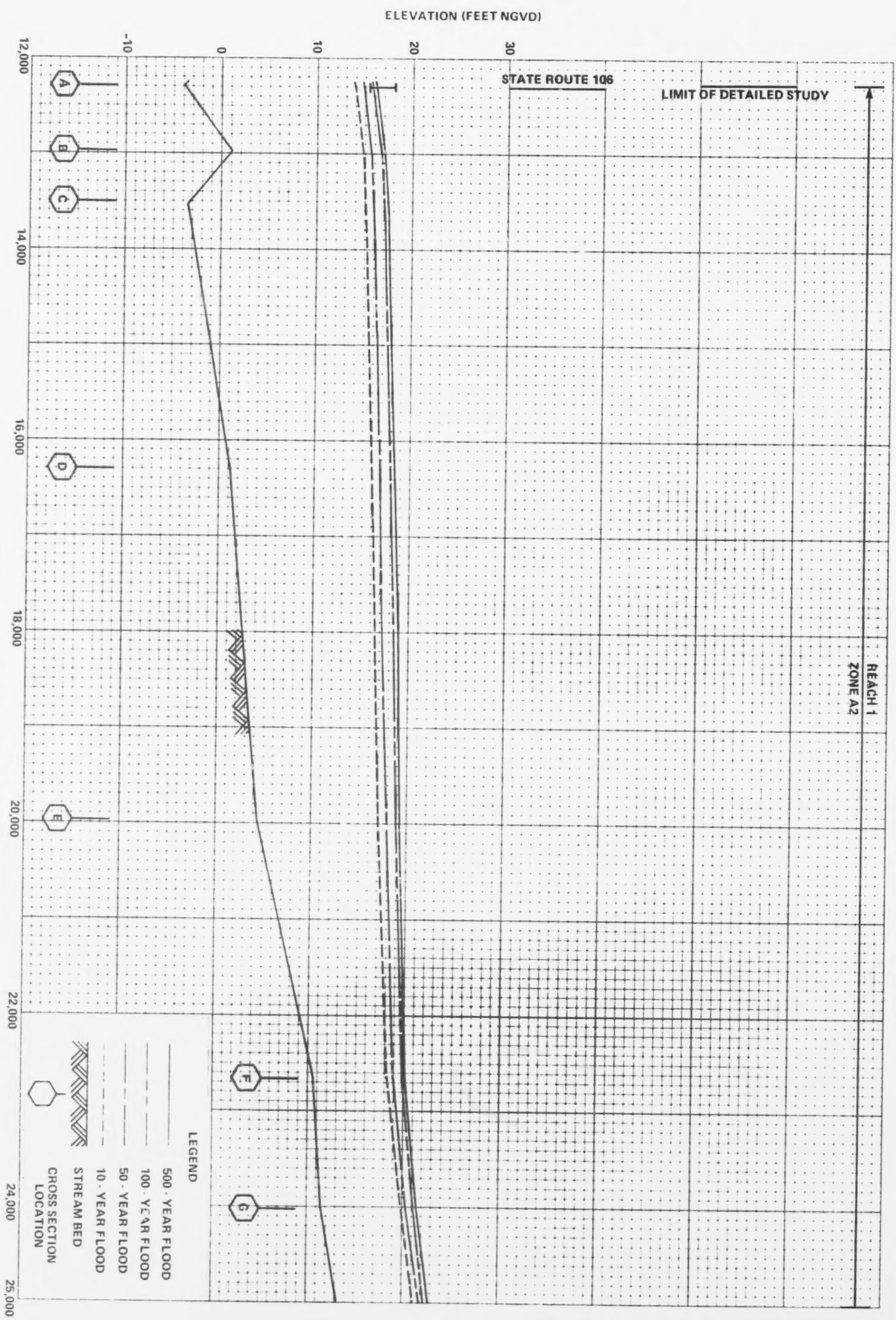
FLOOD PROFILES

TAHUYA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

06P



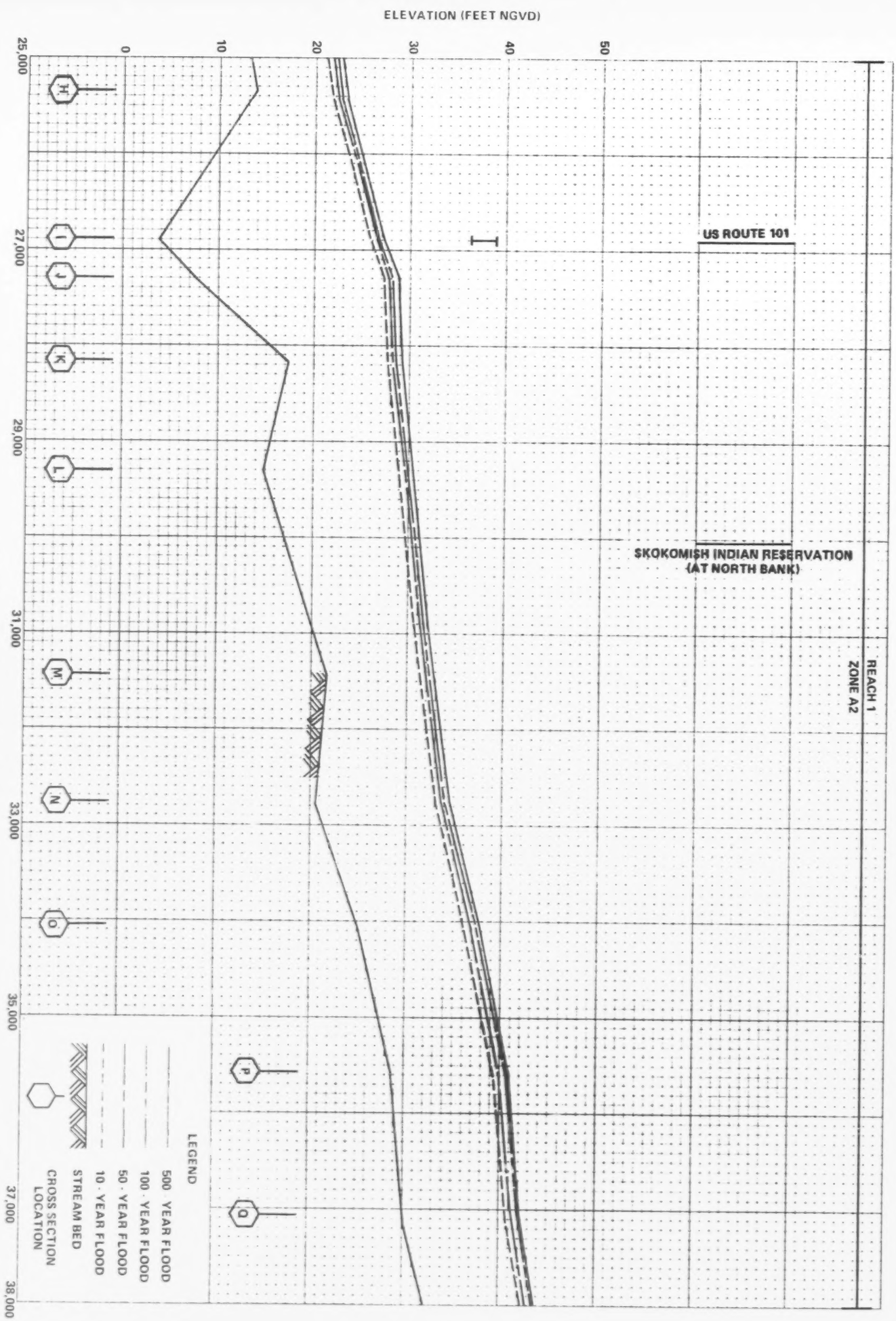
07P

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

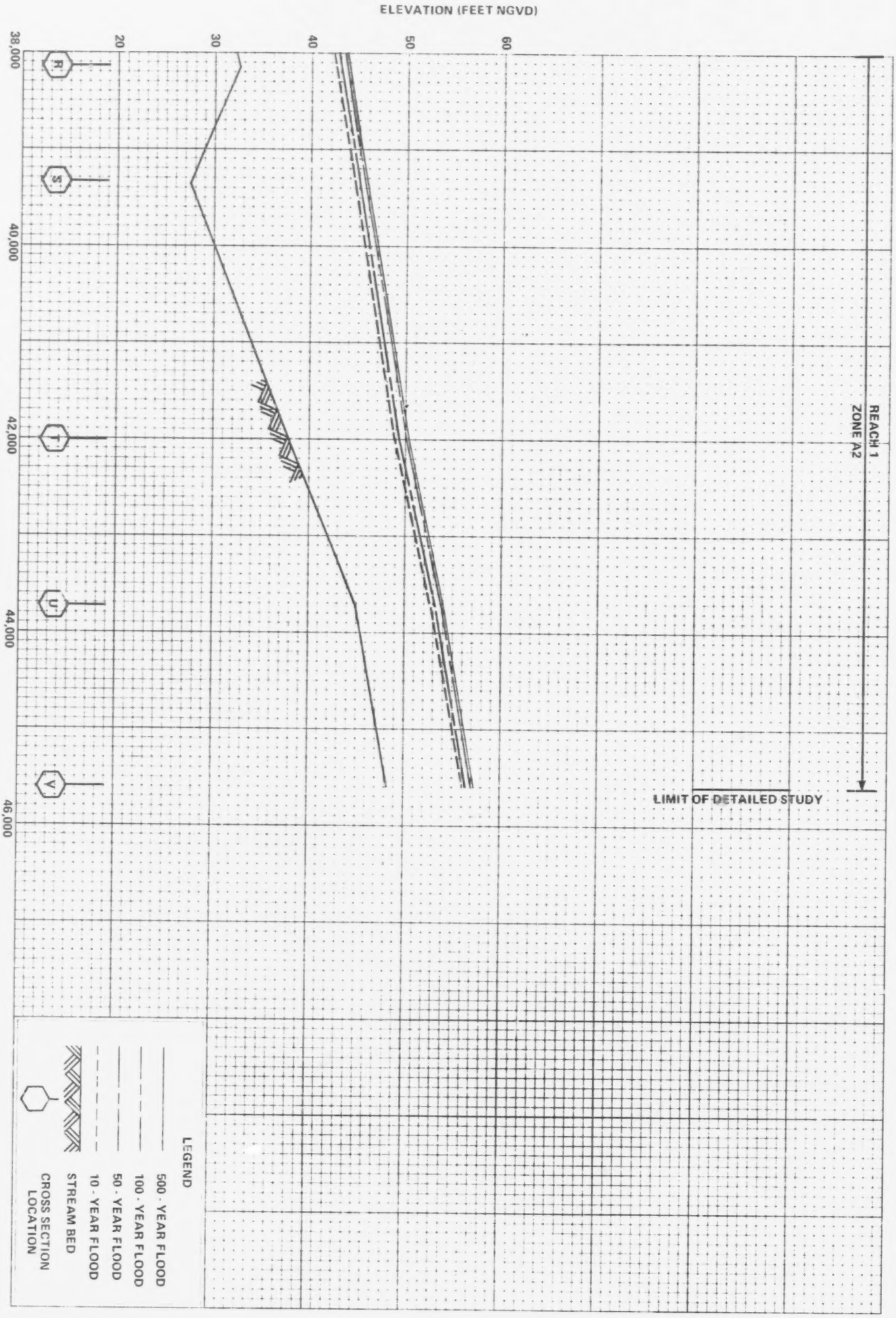
FLOOD PROFILES

SKOKOMISH RIVER



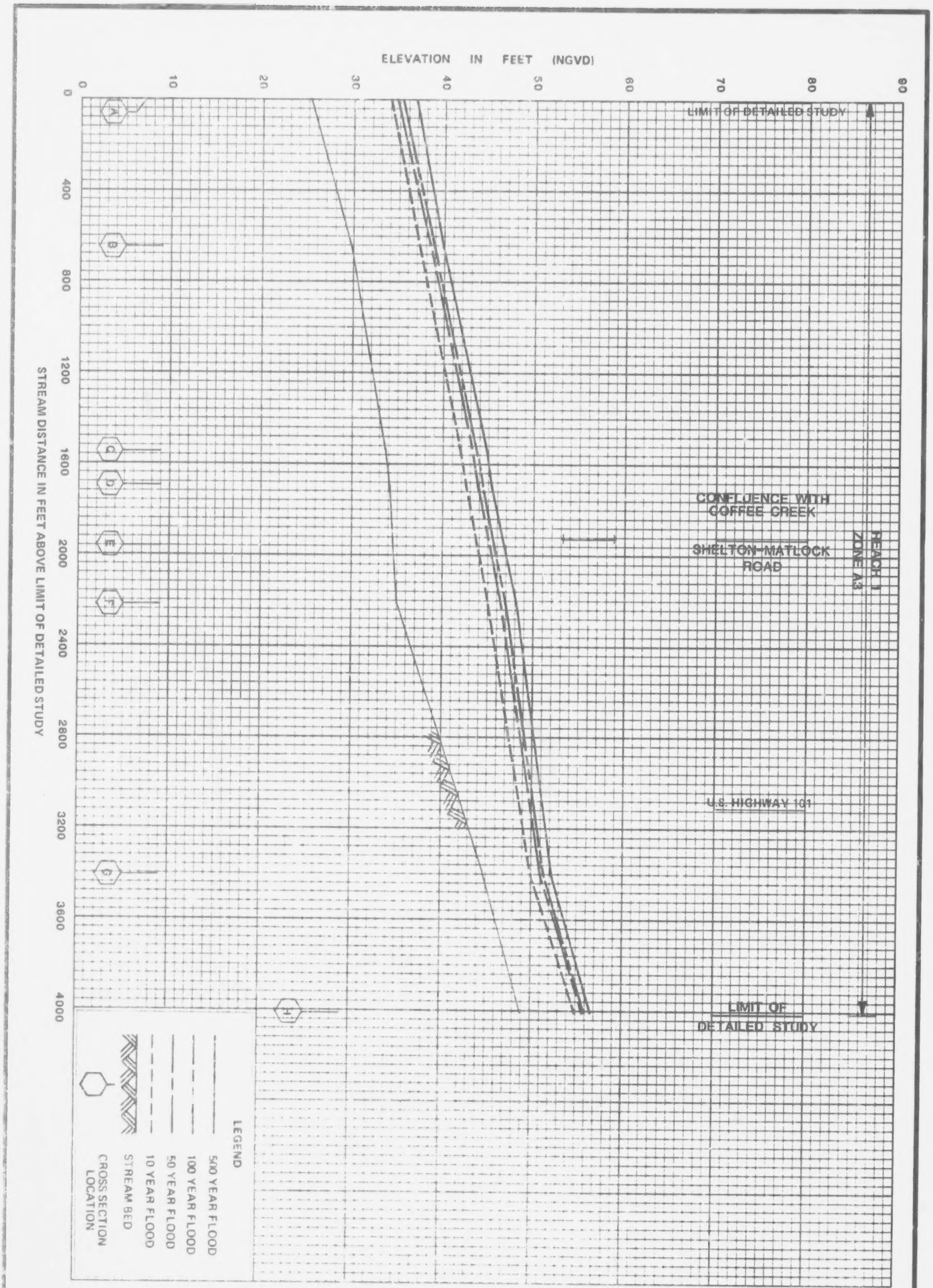
38

08P	FEDERAL EMERGENCY MANAGEMENT AGENCY MASON COUNTY, WA (UNINCORPORATED AREAS)	FLOOD PROFILES SKOKOMISH RIVER



39

09P	FEDERAL EMERGENCY MANAGEMENT AGENCY MASON COUNTY, WA (UNINCORPORATED AREAS)	FLOOD PROFILES SKOKOMISH RIVER



10P

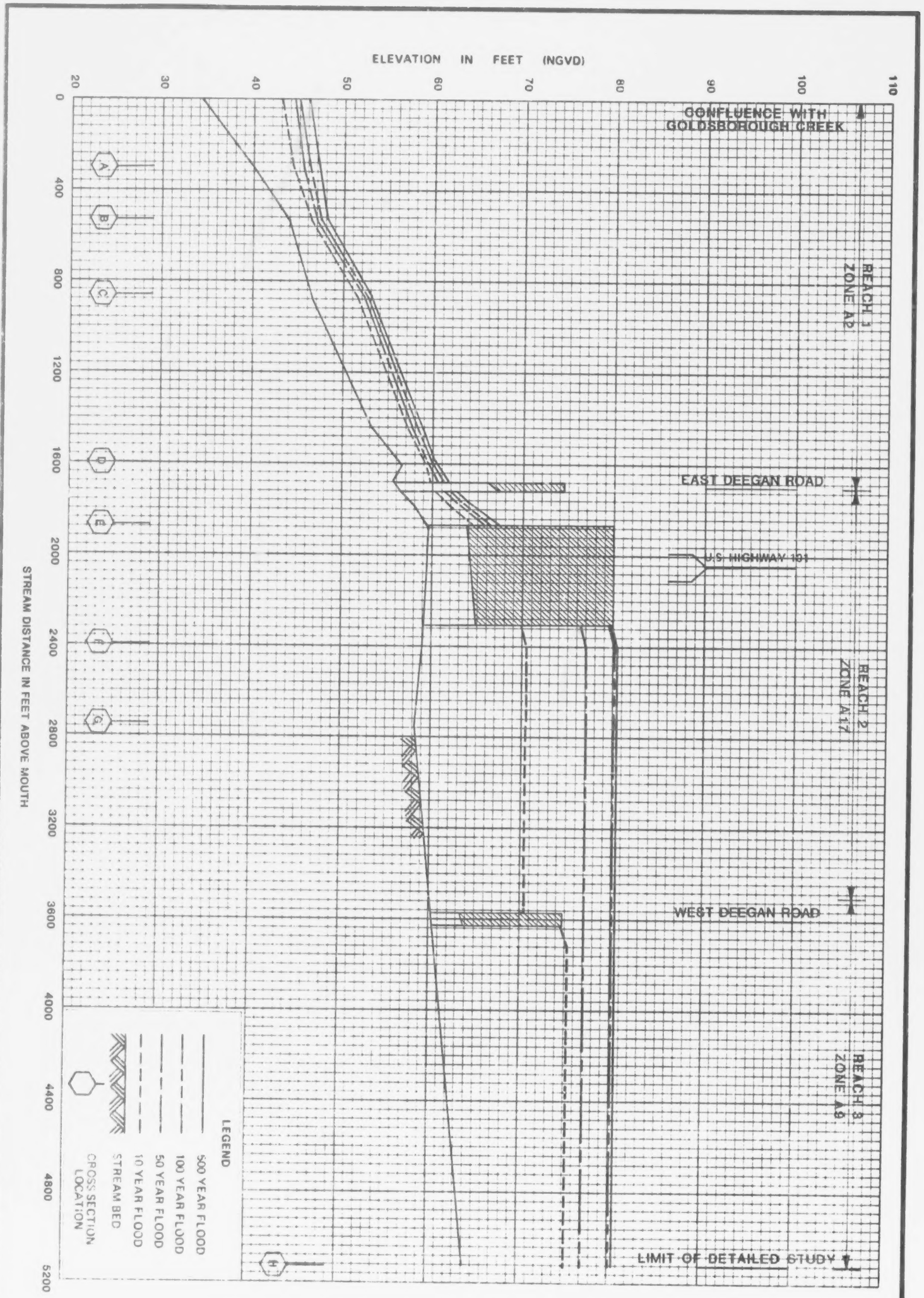
FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA

(UNINCORPORATED AREAS)

FLOOD PROFILES

GOLDSBOROUGH CREEK



11P

FEDERAL EMERGENCY MANAGEMENT AGENCY

MASON COUNTY, WA
(UNINCORPORATED AREAS)

FLOOD PROFILES

COFFEE CREEK